Grahani, Gut Microbiome Dysbiosis and Type 2 Diabetes Mellitus: Exploring an Ayurvedic – Modern Pathophysiological Link

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Abstract

Type 2 diabetes mellitus (T2DM) is a complex metabolic disorder characterised by insulin resistance, impaired glucose homeostasis, and chronic low-grade inflammation. Increasing evidence indicates that the gut microbiome contributes to nutrient metabolism, intestinal barrier integrity, immune regulation, and host metabolic homeostasis. Alterations in gut microbial composition and function, commonly referred to as dysbiosis, have been associated with T2DM and may influence metabolic health through microbial metabolites, intestinal permeability, and inflammatory pathways.

Ayurveda describes *Grahani Roga* primarily in association with impairment of *Agni*, resulting in disturbed digestion and abnormal bowel function. Although *Grahani* should not be equated with gut dysbiosis or any single modern gastrointestinal disorder, its emphasis on digestive function provides a conceptual framework for investigating intestinal microbial and metabolic alterations.

This narrative review explores the possible relationship between *Grahani Roga*, impaired *Agni*, gut microbiome dysbiosis, and T2DM. A proposed pathway linking disturbed digestive function with microbial dysbiosis, altered short-chain fatty acid metabolism, intestinal barrier dysfunction, inflammation, and insulin resistance is discussed. This proposed relationship should presently be regarded as a hypothesis-generating framework rather than an established causal pathway. Future studies integrating Ayurvedic assessment of *Grahani* and *Agni* with gut microbiome profiling and metabolic biomarkers may provide objective evidence for this proposed Ayurvedic–modern connection.

Keywords: Agni; Ayurveda; gut dysbiosis; gut microbiome; Grahani Roga; insulin resistance; short-chain fatty acids; type 2 diabetes mellitus.

Introduction

Type 2 diabetes mellitus (T2DM) is a major metabolic disorder resulting from complex interactions among dietary factors, physical inactivity, adiposity, and environmental influences. Its pathophysiology involves insulin resistance, progressive β-cell dysfunction, altered lipid metabolism, and chronic low-grade inflammation[(1)].

Traditionally, this disease has been approached primarily through the regulation of blood glucose and associated metabolic risk factors. However, contemporary research has increasingly highlighted the role of the gastrointestinal tract and its microbial ecosystem in metabolic regulation[(2-4)].

The human gastrointestinal tract contains a diverse microbial community that participates in digestion, fermentation of dietary substrates, nutrient metabolism, immune regulation, and maintenance of intestinal integrity. Gut microorganisms produce a wide range of metabolites, including short-chain fatty acids, secondary bile acids, and other bioactive molecules that can influence host metabolism.[3] Alterations in microbial composition and function, collectively referred to as gut dysbiosis, have increasingly been associated with obesity, insulin resistance, and T2DM[(5-7)].

Ayurveda provides a conceptual framework for understanding gastrointestinal and metabolic health through the principles of *Agni* and *Grahani*. Classical Ayurvedic descriptions place *Grahani* in close association with properly functioning *Agni*, while impairment of *Agni* is considered central to the development of *Grahani Roga*[(8)].

This narrative review therefore explores the potential relationship between *Grahani Roga*, gut microbiome dysbiosis, and T2DM, and proposes an Ayurvedic–modern pathophysiological framework for future investigation[(9)].

Methods

This article is a narrative (non-systematic) review. Relevant literature was identified through targeted searches of classical Ayurvedic texts (primarily *Charaka Samhita*) and contemporary biomedical literature on gut microbiome, short-chain fatty acids, intestinal barrier function, and type 2

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diabetes mellitus. Priority was given to peer-reviewed reviews, metagenomic studies, and mechanistic papers published in recent years. No formal systematic search protocol, inclusion/exclusion criteria, or risk-of-bias assessment was applied; therefore, this work does not meet the requirements of a PRISMA-compliant systematic review. Findings are synthesised conceptually to generate a hypothesis-generating framework rather than to quantify effect sizes or establish causality.

Ayurvedic Understanding of Grahani Roga

In Ayurveda, *Grahani* is described as a functional component closely associated with the digestion and retention of food, with its proper functioning dependent upon the status of *Agni*. When *Agni* functions normally, digestion and assimilation occur appropriately; impairment of *Agni* may result in disturbed digestion and abnormal bowel manifestations.

Classical descriptions of *Grahani Roga* include variable stool consistency and frequency, indigestion, anorexia, abdominal distension, weakness, and other gastrointestinal manifestations depending upon the underlying *Dosha* and the severity of *Agni* impairment. The central role assigned to *Agni* indicates that gastrointestinal health in Ayurveda is not considered merely a local intestinal phenomenon but is closely connected with the transformation and utilisation of ingested food[10].

Agni and Gut Microbiome Dysbiosis

In Ayurveda, *Agni* represents the functional principle responsible for the digestion and transformation of ingested food and is considered fundamental to maintaining physiological homeostasis[6]. Modern research demonstrates that digestion and nutrient handling are not solely host-mediated; the gut microbiota actively participates in the metabolism of dietary carbohydrates, amino acids and other nutrients and produces bioactive metabolites that influence intestinal and systemic physiology. Dietary composition and nutrient availability, in turn, shape the structure and metabolic activity of the gut microbiome, establishing a bidirectional relationship between diet, digestion and microbial ecology[11].

From this perspective, *Agnimandya* may be explored as an Ayurvedic framework for studying disturbances of digestive and intestinal homeostasis, rather than being directly equated with dysbiosis. Altered microbial activity can influence short-chain fatty acids, bile-acid signalling, intestinal barrier integrity and immune responses, while disruption of the intestinal environment can further modify microbial composition and function.Thus, a possible translational pathway may be proposed as: *Agnimandya* → altered digestive/intestinal environment → altered microbial composition and function → microbial metabolite imbalance → impaired intestinal homeostasis and metabolic dysfunction. However, this proposed relationship remains to be established, and clinical studies integrating standardised assessment of *Agni* with gut microbiome composition and microbial metabolites are needed to further elucidate its biological relevance[12].

Gut Microbiome Dysbiosis and Type 2 Diabetes Mellitus

Gut microbiome dysbiosis is increasingly associated with the development and progression of type 2 diabetes mellitus (T2DM). Metagenomic studies have demonstrated alterations in microbial composition and function in individuals with T2DM, with disturbances in pathways related to nutrient metabolism and host–microbial interactions[13].

Dysbiosis may alter microbial metabolites such as short-chain fatty acids and bile acids, impair intestinal barrier integrity and promote low-grade inflammation, thereby contributing to insulin resistance and impaired glucose homeostasis.

However, microbial profiles vary with diet, obesity, ethnicity, geography and medication exposure; therefore, no single microbial pattern can currently be considered a universal signature of T2DM[14].

Proposed Grahani–Gut Microbiome–T2DM Connection

The Ayurvedic concept of *Grahani*, particularly its association with impaired *Agni*, can provide a hypothesis-generating framework for understanding the relationship between digestive dysfunction, gut microbial dysbiosis and metabolic disease.

Impaired digestion may be conceptually linked with alterations in the intestinal environment and substrate availability, while the gut microbiome actively participates in nutrient metabolism and produces metabolites such as short-chain fatty acids (SCFAs) that regulate intestinal and systemic metabolic homeostasis. In T2DM, dysbiosis has been associated with altered microbial metabolites, impaired intestinal barrier function, increased inflammatory signalling and insulin resistance[15].

The proposed relationship can be represented as follows:

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Grahani Roga / Agni dysfunction

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Altered digestion and intestinal homeostasis

↓

Gut microbial dysbiosis

↓

Intestinal barrier dysfunction and increased permeability

↓

Low-grade systemic inflammation

↓

Insulin resistance

↓

Type 2 diabetes mellitus

Discussion

The emerging evidence indicates that digestive function, gut microbial ecology and metabolic health are interconnected. The Ayurvedic concept of *Agni* provides a functional perspective on digestion and assimilation, whereas contemporary research demonstrates that the gut microbiome influences nutrient metabolism, intestinal barrier function, immune responses and glucose homeostasis[16].

In T2DM, dysbiosis has been associated with altered microbial metabolites, increased intestinal permeability, low-grade inflammation and insulin resistance. These observations provide a plausible biological context in which the *Grahani–Agni* concept may be explored in relation to the gut–metabolic axis. Variations in diet, obesity, medication, geography and host characteristics further complicate interpretation of microbiome findings. Therefore, the proposed relationship should be considered a translational hypothesis requiring clinical validation.

Limitations of the present review include its narrative (non-systematic) design, absence of a predefined search protocol, and lack of quantitative synthesis. Consequently, selection bias and incomplete coverage of the literature cannot be excluded. The conceptual model remains hypothesis-generating and should not be interpreted as evidence of causality[17].

Conclusion

The proposed *Grahani*–gut microbiome–T2DM framework offers a novel approach to understanding metabolic disease through the integration of Ayurvedic and contemporary biomedical perspectives. The model suggests that disturbances in digestive function may be investigated alongside alterations in microbial composition, microbial metabolites, intestinal barrier integrity and metabolic inflammation.

Future research should employ standardised *Agni* and *Grahani* assessment, microbiome profiling, metabolomic analysis and metabolic biomarkers in well-designed clinical studies. Longitudinal and multi-omics studies may help determine whether microbial and metabolic changes are consequences or potential mediators of digestive dysfunction. Establishing these relationships could strengthen the scientific interpretation of Ayurvedic concepts and may identify new biomarkers and personalised preventive or therapeutic strategies for T2DM.

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Conflict of Interest: Nil

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